4.1 Force and Motion

I. Force - a push or a pull
  A. The larger the push/pull the larger the force
    1 Symbol F is vector notation that represents size + direction of a force
      a. Magnitude of a force is measured in Newtons (N)
  B. Unbalanced Forces Change Motion (net)
    1. all accelerations are a result of an unbalanced force
  C. Systems and external World
    1. Objects of interest (systems) interact with the external world resulting in motion
  D. Contact Forces
    1. Contact forces exist when an object from the external world touches the system, exerting a force

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E. Field Force - forces exerted without contact with the system
F. Agents - indentifiable cause of contact + field forces
  1. agent of gravity = mass of Earth
G. Free-Body Diagrams - physical representation that shows forces acting on a system
  1. Guidelines
    a. Free-body diagram is drawn separately from sketch of problem situation
    b. Represent the object with a dot (like particle model)
    c. Represent each force with a vector pointing away from the particle
    d. make force vector proportional to the size of force
    e. label each force
    f. choose a direction to be + (positive) and (-)

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II Combining Forces
A. The vector sum of all forces acting on an object is a net force

III Acceration + Force ($F=ma$)
A. Spring Scales are able to exert a constant unbalanced force
B. Recall slope of a velocity-time graph = acceleration
1. A linear relationship exists between force + acceleration
a. $y = kx + b$ $F = ma$
b. y intercept = $\emptyset$ so $y = kx$
2. Units of force = $N = kg \cdot m/s^2$
C. Newton's 2nd Law = $F = ma$

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1. It is important to find the correct net force

IV Newton's 1st Law
A. Objects at rest will remain at rest unless a net force acts on the object and an object in motion will remain in motion unless a net force acts on object
B. 1st Law is summarized as law of inertia
1. Inertia is not a force
2. If net forces are balanced, object is in equilibrium

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4.2 Weight + Drag Force

I. Weight - the force of gravity on an object
   A. $F = mg \rightarrow g = a \rightarrow 9.8\ m/s^2$
   B. Scales work by balancing the force of gravity on your mass
      1. Springs inside scale react to your weight and measures the amount of force needed to balance your weight
   C. Apparent Weight
      1. Weight in an elevator will change due to the elevator's acceleration
   D. When you experience zero gravity (it feels as if you are weightless), you have an apparent wright of 0

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II Drag Force
   A. Particles of air around an object exert a force on the object
      1. Generally, these forces are balanced
         a. However, sometimes, these forces are not balanced
   B. When an object moves through a fluid (air, water, etc.) the fluid exerts a force on a moving object in a direction opposite the motion
      1. This is known as a drag force
   C. When a drag force equals the force of gravity, an object does not accelerate anymore
      1. This is known as terminal velocity

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5.3 Newton's Third Law

I. Interaction Pairs

A. Equal + Opposite Forces

1. The two forces either exist together or not at all

B. Definition of Newton's Third Law

1. For every force, there is an equal and opposite force

a. $F_{A\ on\ B} = -F_{B\ on\ A}$

2. Law states that all forces come in pairs

3. Due to Earth's massive size, we can treat Earth as part of an external world instead of a second system

C. Problem-solving strategies

→ become familiar with steps 1-7 on p. 259

Ex: A softball has a mass of .18 kg. What is the gravitational force on Earth due to the ball and what is Earth's resulting acceleration?

Known

$m_{ball} = .18 kg$

$m_{Earth} = 6.0 \times 10^{24} kg$

Unknown

$F_{Earth\ on\ ball} = ?$

$a_{Earth} = ?$

$.18(-9.8 m/s^2) = F_{E\ on\ b} = -1.8N$

$a = \frac{1.8}{6.0 \times 10^{24} kg} \rightarrow 2.9 \times 10^{-25} m/s^2 = a$

→ practice # 28-31

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II Tension

A. a specific name of a force for a rope or a string

1. Assumes all ropes/strings are massless

→ Look Example problem 5 (p. 264)

III The Normal Force

A. Anytime two objects are in contact with each other, they exert a force on each other

B. The perpindicular contact force that a surface exerts on another surface = normal force

1. Normal force is not always equal to the weight of the object it exerts a force on

→ Figure 20

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